Assessment and Management of Acute Burn Injuries

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KEYWORDS

• Acute burn • Burn assessment • Early burn management

KEY POINTS

- Burn injuries are a global problem that can result in significant functional, cosmetic, and physiologic derangements.
- The acute assessment and management of burn-injured patients is a critical part of their short-term and long-term outcomes and often benefit from specialty, multidisciplinary care.
- Judicious fluid resuscitation for large burns and diligent local wound care is important to the survival of the patient and success of the future skin grafts.

INTRODUCTION

Over 450,000 burn injuries occur each year in the United States requiring medical attention with an estimated 4000 resulting in death.[1] Globally, burn injuries are also a significant healthcare problem, with an estimated 180,000 deaths annually.[1] These injuries are caused by a variety of mechanisms such as scalds, flame, chemicals, or electricity in settings from the home to the workplace resulting in significant pain, physical disability, psychosocial disorders, and in some cases, death. Minimizing the impact of burn injury begins with prevention. This includes education about safe practices for handling flammable substances, using protective gear when working with hot materials, installing smoke detectors and fire extinguishers in homes and workplaces, and supervising children around cooking, fires, outlets, and other hazards.

When prevention fails, rapid assessment and management of acute burn injuries are essential to improving patient outcomes. Initial management of acute burns involves the principles of Advance Burn Life Support (ABLS)[2] and the primary survey, which provide guidance for the management of the initial burn up to 24 hours postinjury.

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SHOUT
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IT

In cases where mechanical trauma is present with the burn injury, Advanced Trauma Life Support (ATLS)[3] should also be followed.

Effective management of burn injuries requires a multidisciplinary team including prehospital providers, burn surgeons, nurses, physical and occupational therapists, psychologists, nutritionists, and family support. Here we focus on the provider assessment and initial management of acute burns.

PATIENT EVALUATION

Acute burn injuries are defined as tissue damage caused by thermal, chemical, electrical, or radiation exposure. They are classified according to the mechanism, depth of injury, location, and total body surface area (TBSA) affected. Patient factors may contribute to the overall severity of the burn including medical comorbidities, concomitant trauma, presence of inhalational injury, and age.

Life-threatening injuries should be identified and treated in the primary survey. The primary survey evaluates the airway, breathing, circulation, disability, and exposure. Large-bore peripheral IVs should be secured and may be placed through burns; Intraosseous access should be used if peripheral IVs cannot be obtained rapidly. Initial fluids should be started during this time for large burns which will be discussed further in the resuscitation section later in discussion. Once immediate life threats are addressed, we proceed with the secondary survey which includes a complete physical exam and detailed burn assessment including history, depth, and size. It is important to remove jewelry which may a tourniquet effect as the patient becomes edematous and be mindful of hospital bands.

Burn Mechanism

The mechanism describes the inciting agent leading to the burn. It may be scald, flame, contact, electrical, radiation, or chemical. Each may give clues to other potential injuries, such as a flame burn in an enclosed area increasing the risk for inhalational injury, or an electrical injury increasing the risk of other traumatic injuries such as fracture or dislocation. It is also important to understand the circumstances under which the injury occurred, for example, when the reported mechanism does not match the injury, this may raise the concern for abuse or neglect in vulnerable populations.

Burn Depth

Depth is determined by the temperature, duration of contact, and skin thickness of the exposed area (**Fig. 1**). Superficial burns, also known as first-degree burns, involve only the epidermis and usually heal without scarring in 3 to 4 days. They are characterized by erythema and are painful to the touch but do not blister. A classic example of a first-degree burn is a sunburn (**Fig. 2**A). These are not included in the calculation of burn size. Treatment includes symptom control and topical moisturizers. Partial-thickness burns, or second-degree burns, involve the epidermis and part of the dermis, leaving some epithelial elements (**Fig. 2**B). They can further be subdivided into superficial and deep. Superficial partial thickness burns are painful and blister with the underlying wound maintaining moisture and a blanching pink color; typically, these take 2 to 3 weeks to heal. Deep partial thickness burns are painful, paler pink that may progress to white; typically, these take 3 to 9 weeks to heal and may result in severe scarring and loss of function. Many deep partial thickness burns benefit from excision and grafting to accelerate wound closure.[4–6] Full-thickness burns (previously third-degree burns), extend through the epidermis and

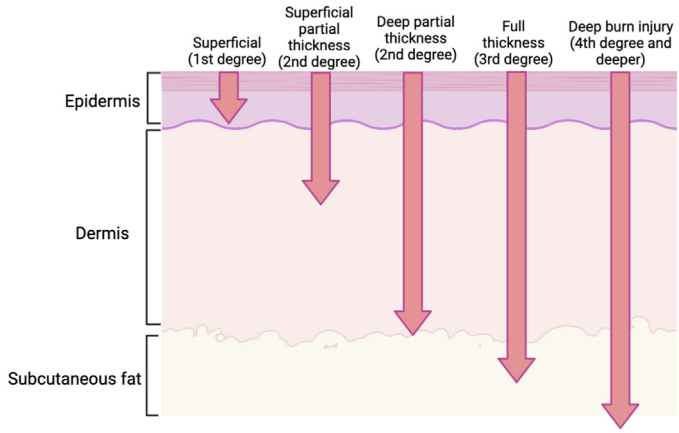


Fig. 1. Burn depth. (Created with Biorender.com.)

Fig. 2. Clinical examples of different burn depth. (*A*) Superficial burn. (*B*) Partial thickness burn. (*C*) Full-thickness burn. (*D*) Very deep burn injury. (Photo credit [*A–C*] Ashley Sanders, PA-C; [*D*] Alison Haruta, MD.)

dermis (Fig. 2C). They are insensate, non-blanching wounds that may appear white or deep red under eschar that may be black. There may be initial blistering but the underlying skin is dry. These are often seen with flame burns and grease burns and are typically treated with excision and grafting. Very deep burn injuries (4th-6th degree), extend into the subcutaneous tissue and sometimes down to muscle or bone. These burns can be seen with electrical injuries or deep thermal burns to areas with thinner skin (Fig. 2D).

Burn Size

Burn size accounts for the surface area of burn that is partial thickness and deeper. For smaller burns, the size may be estimated using the patient's palm and fingers which represents 1% TBSA (Fig. 3). One method to estimate the size of larger burns is by using the rule of nines, which divides the body into regions, each representing 9% or multiples of 9% TBSA (Fig. 4). The Lund and Browder chart considers the age of the patient since body proportions change over time (with children having relatively

Fig. 3. Palm and finger method for estimating %TBSA.[2] (Credit: 2018 American Burn Association, ABLS provider manual.)

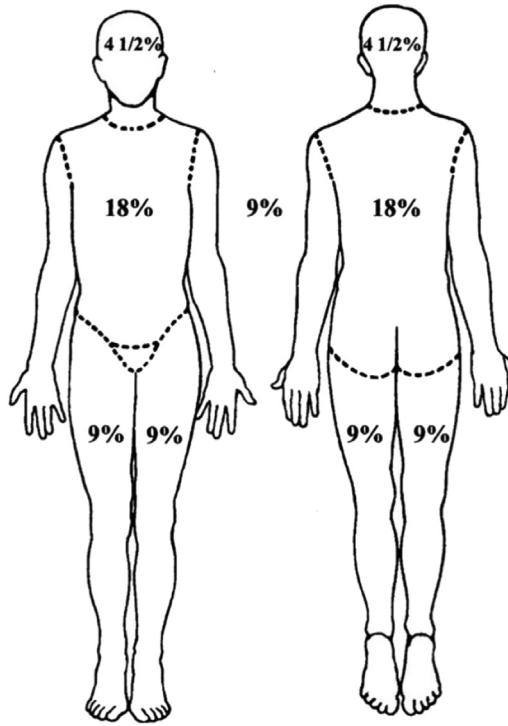
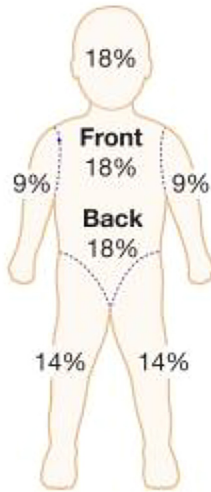


Fig. 4. Rule of 9's.[2] (Credit: 2018 American Burn Association, ABLS provider manual.)

larger heads and smaller lower extremities compared to adults) and subdivides body parts into smaller units to aid in more accurate calculations (**Fig. 5**). Newer tools include software such as Pixamed and smartphone apps which aim to rapidly and accurately calculate %TBSA.[7,8]



Child body	% of total
Part	BSA
Arm	9%
Head and neck	18%
Leg	14%
Anterior trunk	18%
Posterior trunk	18%

Fig. 5. Lund and Browder Chart.[2] (Credit: 2018 American Burn Association, ABLS provider manual.)

TRANSFER TO SPECIALTY BURN CARE

The American Burn Association (ABA) has established verification criteria for burn centers to ensure that verified burn centers provide high-quality specialty burn care. Some burns can safely be managed outside of these centers and the ABA has established criteria to transfer (**Table 1**).[1] The patient should be stabilized with any life-threatening injuries addressed. The wounds can be covered with clean dressings and the patient should be kept warm. For larger burns, IV access should be secured and a foley catheter placed to closely monitor urine output. For longer transport times, a plan should be in place for adjusting resuscitation fluid rates (see later in discussion).

RESUSCITATION

Early and appropriate volume resuscitation is crucial. Burn injury leads to increased vascular permeability beginning at the time of injury, peaking around 8 to 10 hours post burn, and persisting for about 24 hours post burn. The capillary leak allows fluid to pass into the extravascular space, and the degree of leak is proportional to the % TBSA.[9,10] Burns involving more than 20% TBSA in adults or 15% TBSA in children require fluid resuscitation as the capillary leak is no longer localized but becomes systemic. The goal of fluid resuscitation in burn-injured patients is to replace the intravascular volume and prevent shock. Under resuscitation leads to hypotension and organ dysfunction, while over resuscitation leads to pulmonary compromise, compartment syndromes, and other complications.

Fluid Rates

In the prehospital or emergency department setting, a patient may have a large burn but an exact %TBSA is not yet available. During the primary survey, we use standard initial fluid rates based on age until a %TBSA is calculated in the secondary survey. The American Burn Association recommends starting lactated ringers at 125 cc/h

Table 1
ABA burn referral criteria[1]

	Immediate Consultation with Consideration for Transfer
Thermal Burns	• Full thickness burns • Partial thickness ≥ 10% TBSA • Any deep partial or full thickness burns involving the face, hands, genitalia,feet, perineum,or over any joints • Patients with burns and other comorbidities • Patients with concomitant traumatic injuries • Poorly controlled pain
Inhalation Injury	• All patients with suspected inhalation injury
Pediatrics (≤14 y,or < 30 kg)	• All Pediatrics burns may benefit from burn center referral due to pain, dressing change needs, rehabilitation, patient/caregiver needs, or non-accidental trauma
Chemical Injuries	• All chemical injuries
Electrical Injuries	• All high voltage (≥1,000V) electrical injuries • Lightning injury

American Burn Association. Guidelines for Burn Patient Referral, 2022. https://ameriburn.org/resources/burnreferral/.

for children 5 years and younger, 250 cc for children age 6 to 13 years, and 500 cc/h for patients 14 years and older.

Once a specific %TBSA has been determined calculate predicted fluid requirements using an estimate such as the Parkland formula, Modified Brooke formula, or ABA consensus formula (**Box 1**).[1,11] These calculate the expected 24-hour fluid requirement with the first half being given in the first 8 hours and the second half given over the next 16 hours.

Regardless of the starting rate, fluids are titrated hourly to urine output with a goal of 0.5 mL/kg/h (30–50 cc/h) in adults and 1 to 1.5 cc/kg/h in children. We increase fluids by about 10% if the urine output is not at goal for the previous hour. We use the Burn Navigator for the first 24 hours postburn as an adjunct to help guide resuscitation. The Burn Navigator is a clinical decision tool that uses the patient age, weight, and burn size to calculate a starting fluid rate and recommends hourly changes based on the prior hour's urine output. It also identifies patients that may be "non responders" and should be considered for other interventions. Early results demonstrate lower overall fluid volumes as well as decreased incidence of burn shock.[12–14] While this tool can be helpful to guide resuscitation, it is not a replacement for bedside evaluation and clinical judgment. We bolus for evidence of hypovolemic shock, such as hypotension, but not for low urine output. Other endpoints such as POCUS, lactate, and advanced noninvasive monitoring may be helpful in patients with signs of shock. If the urine output is at goal, the fluids should be down titrated; providers must be diligent to minimize the burden of fluid overload by decreasing excess fluid administration. After the initial 24 hours postburn has passed, we decrease fluids as able by about 10% per hour until a weight-based maintenance rate is reached.

Pediatric Considerations

Pediatric patients around 30 kg or smaller have higher volume to surface area and lower glycogen storage, so they require maintenance fluids in addition to their calculated resuscitative rate as well as dextrose supplementation. We recommend adding D5LR at a weight-based maintenance rate that remains constant throughout the acute phase.

Box 1
ABA consensus resuscitation formula

- 2 to 4 mL/kg/% TBSA for the first 24 h postburn
  - Give 1/2 over the first 8 hours postburn
  - Give 1/2 over the next 16 hours postburn
- Adults: 2 mL/kg/% TBSA
- Children: 3 mL/kg/% TBSA
- Electrical: 4 mL/kg/% TBSA

In adults:
- Adjust fluid rate hourly for goal urine output 0.5 mL/kg/h

In children:
- Adjust fluid rate hourly for goal urine output 1 mL/kg/h
- If < 30 kg, add dextrose containing fluid at weight based maintenance rate in addition to the resuscitative fluids.

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FAILING RESUSCITATIONS

Early identification of a failing resuscitation is important to promptly initiate rescue therapies and identify nonresponders. Failure can occur anytime during the resuscitation, so frequent reassessment is essential. While there is no clear definition, concerning signs include fluid requirements in excess of the predicted rate, persistent oliguria, worsening acidosis, and hypotension despite fluid escalation.[15] It should also raise concern if at any point the estimated fluid volume exceeds the Ivy index, or 250 mL/kg, as this has independently been associated with increased mortality[16,17] Some reasons for failure include the underestimation of burn size, delayed presentation, concurrent inhalation injury, electrical injury, or trauma.

Albumin

One adjunct for a difficult resuscitation is albumin, which in theory increases the oncotic pressure to decrease fluid leakage, though clinical utilization is variable.[18,19] Colloids have a long history in burn resuscitation, but use declined as crystalloids provided effective resuscitation. A 1998 review noted higher risk of death in patients who received albumin.[19,20] In 2000, the problem of over resuscitation, termed "fluid creep," was described which renewed an interest in colloid use.[21] Currently, it is used by most as a "rescue" adjunct to failing resuscitations and several studies suggest that this improves outcomes.[22–24] The *Acute Burn Resuscitation Multicenter Prospective Trial (*ABRUPT), a prospective observational study again demonstrated the variability of albumin use with 2/3 of the enrolled patients receiving albumin at 15h $\pm$ 8.4 h postburn; it also showed albumin rescue was used most frequently in older patients, larger/deeper burns, and patients with more severe organ dysfunction at presentation, improving the in/out balance in patients whose crystalloid volumes were in excess of predicted.[25] *The Acute Burn Resuscitation Multicenter Prospective Trial (ABRUPT2) is a prospective randomized trial currently enrolling to look at early albumin vs crystalloid only resuscitation.* In our practice, we typically use albumin as an adjunct in patients not responding to resuscitation at 8 to 12 hours postburn, starting at a rate 1/3 of the crystalloid rate.

Fresh Frozen Plasma

FFP is an effective volume expander, decreasing fluid volumes and improving clinical outcomes when added to resuscitation,[26,27] however cost, availability, risk of bloodborne disease transmission, and its association with the development of transfusion-related lung injury has limited its widespread clinical use. Animal models have demonstrated that the endotheliopathy of trauma, mediated by damage to the endothelial glycocalyx, is partially reverses by FFP, but not by LR or albumin, to mitigate the vascular permeability in animal hemorrhage models.[28–30] Similarly, the endotheliopathy of burns appears to occur via the same mechanism, suggesting that plasma may mitigate the capillary leak and improve outcomes when used as a resuscitation fluid. The Plasma Resuscitation without Lung Injury (PROPOLIS) trial is a prospective, randomized control trial currently enrolling to evaluate plasma versus crystalloid based burn resuscitation, however there is not presently a standard protocol for plasma use in burns.

Blood Purification

Plasma exchange can also be used as an adjunct to resuscitation. It is thought to remove the inflammatory mediators of burn shock. There is some retrospective data that demonstrate a benefit to plasma exchange as a rescue therapy with a subsequent

decrease in fluid rates, decrease in lactate, and increase the urine output and blood pressure[31–33] though prospective data is lacking.

Another method of clearance is high volume hemofiltration (HVHF) which may have a role in failing burn resuscitation, though data here is also limited. In burn patients with septic shock, it was found to reverse the shock and improve organ dysfunction, though there was no difference in mortality and this was not studied during the initial resuscitation phase as a rescue adjunct.[34]

Ultra-Early Eschar Excision

Typically, the tangential excision occurs after the patient is resuscitated so as not to worsen the physiologic derangements of the burn injury with the stress and consequences of operation. However, the burn eschar is a source of ongoing inflammatory burden, so in the face of refractory shock, early excision within the first 24 hours has been described and may benefit the patient's physiology.[15]

WOUND MANAGEMENT

Initial wound care includes the debridement of the dead tissue and coverage with a dressing until the area heals or can be excised and grafted. The wound should be cleansed thoroughly with soap and water. There are many topical options and dressing materials; there is no perfect dressing, but the goal is to promote healing, prevent infection, and provide comfort to the burned area. They should have antibacterial properties, provide moisture, and keep the wound clean and covered without restricting range of motion. As the wound or graft heals, it will contract, so mobilization and specialized therapy should begin early to minimize loss of function.

Compartment Syndrome and Escharotomies

Compartment syndrome can develop, usually in areas of circumferential full-thickness burn, as the tissue swells, and the burn constricts the area. This can compromise perfusion, as seen in the distal extremities with increasingly tight compartments and diminishing pulses. It can also restrict chest wall and abdominal wall motion which can worsen oxygenation and ventilation manifesting as increased airway pressures. **Fig. 6** demonstrates the typical locations escharotomies are performed but they need not be perfectly located if the pressure is released from the compartment through burned skin. It is more important to avoid nonburned skin and avoid going too deep; escharotomies should be performed just through the eschar to release the dermal bands, but should not go into the subcutaneous fat. Going too deep may lead to bleeding, excess tissue excision, poor graft take, and muscle herniation.

Muscle compartment syndrome may be seen with electrical burns even when the surface injury does not appear as severe. Compartment syndrome is a clinical diagnosis with the patient demonstrating tense compartments, pain out of proportion, and pain with passive motion. Pulselessness, paresthesia, and weakness are late findings. Treatment is with fasciotomies.

Excision and Coverage

Deeper burns typically require excision and grafting. Tangential excision is the standard method used to remove the nonviable tissue to provide a perfused wound bed for grafting. Current consensus recommends excision before the 6th day postburn, and most undergo initial excision within 2 to 5 days postburn. A recent retrospective cohort study across almost 900 US centers found that early excision within 48 hours postburn was associated with fewer complications, shorter ICU stays, and shorter hospital stays.[35]

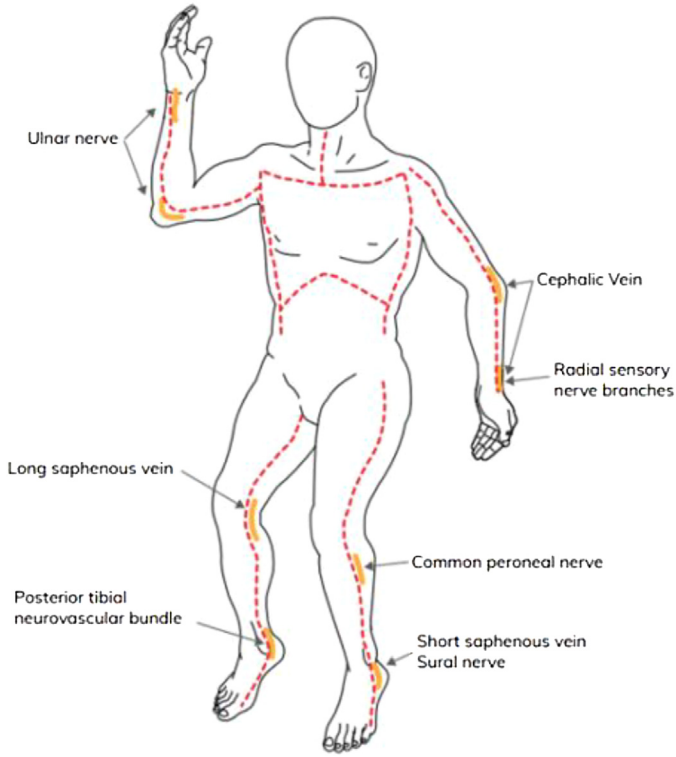

Fig. 6. Escharotomy Incisions and Adjacent Neurovascular Structures. (Credit: Butts CC, Holmes JH, Carter JE. Surgical Escharotomy and Decompressive Therapies in Burns. *J Burn Care Res*. Feb 19 2020;41(2):263-269. https://doi.org/10.1093/jbcr/irz152.)

Large burns sometimes require staged excision as the eschar removal must be balanced against operative time, blood loss, and hypothermia. Many patients require blood transfusions perioperatively. Extremity excisions may be done under tourniquet to mitigate some of this. In contrast, fascial excision removes the skin and subcutaneous tissue down to a relatively avascular fascial plane which often leads to decreased blood loss but may remove more tissue than necessary, resulting in more deformities and functional loss.

Autograft

Excised wounds will usually need an autograft, though the timing depends on the patient's clinical picture, donor sites available, and viability of the wound bed. Most areas are covered with split-thickness skin grafts (STSG) which include the epidermis and partial dermis from the donor site whereas full-thickness skin grafts harvest the epidermis and dermis. STSGs are harvested using a dermatome set to 0.006 to 0.014 inches. These grafts can be placed on the wound bed as a sheet, which we commonly use to cover cosmetic areas such as the neck, hands, and feet (**Fig. 7**A), or meshed to various degrees (**Fig. 7**B). Donor site selection depends on what skin is available, color match, and what will heal with the best cosmesis and least amount of pain. In general, we avoid crossing joints and avoid arms below the elbow and legs below the knee if alternate grafts sites are available; in large burns this is not avoidable,

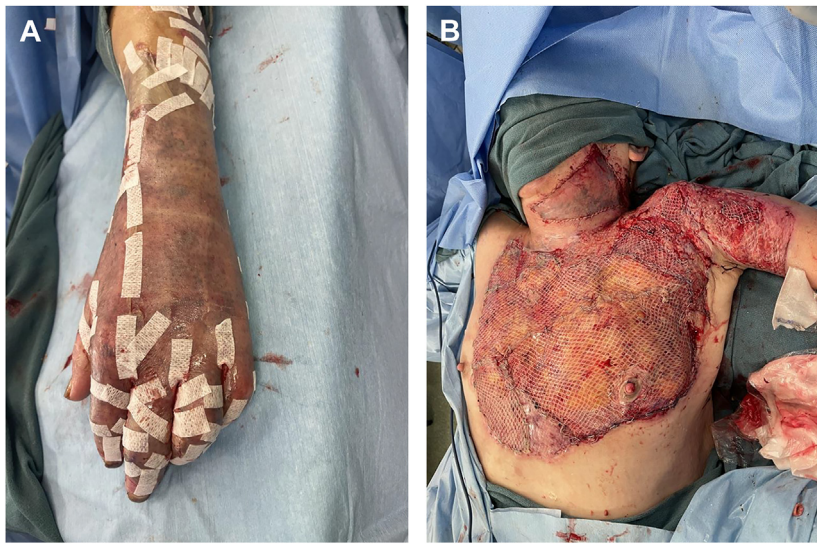

Fig. 7. Grafted Burn Wounds. (*A*) Sheet graft. Photo credit: Sam Mandell, MD. (*B*) Meshed Graft. (Photo credit: Sam Mandell, MD.)

and these areas do provide adequate STSG. The scalp provides good color match for face/neck though may be more difficult to harvest due to the convexity of the scalp.

Grafts are covered with a dressing that is left in place for typically 2 to 5 days depending on the area to minimize shear forces and encourage graft incorporation.

Skin Substitutes

If the wound bed or patient is not ready for autografting, there are temporary coverage options to protect the wound bed and minimize insensible losses. Allograft, donated human cadaver skin, is commonly used for temporary grafting or on top of a widely meshed graft to protect it and confer a coverage benefit. In the latter example, the allograft is allowed to separate and slough off as the autograft heals in. If only allograft is covering the wound bed, these patients typically need another operation in about 1 to 2 weeks for repeat excision and autografting. Acellular fish skin xenografts may be a future option for temporary coverage.[36]

Myriad biologic and synthetic options are also on the market which we use on a case by case basis. They may provide temporary coverage to a large or poorly vascularized wound bed, act as a scaffolding for the dermal matrix formation, or be used in conjunction with an STSG to accelerate revascularization and healing. This is not meant to be a comprehensive review of these products but rather to mention that alternatives are being developed for coverage of wounds that may be too deep, too large, or otherwise not ready for autografting.

Epidermal Autografts

Epidermal Autografts, (RECELL, Valencia, CA), or "spray on skin," utilizes a small sized STSG which is enzymatically and mechanically processed to suspend epidermal cells is a buffer. These are then applied to the prepared wound bed. We selectively use this method to cover partial thickness burns if healthy dermis appears present after excision. Current data suggests decreased donor site requirements and faster healing with

less scarring, fewer procedures to wound closure, and shorter lengths of stay for small burns.[37–39] It can also be used in combination with meshed autografts to help fill in the interstitial spaces and accelerate healing.

CONSEQUENCES OF HYPERMETABOLISM

Large burn injuries lead to a profound alteration in metabolism with high rates of protein catabolism leading to muscle wasting and end-organ dysfunction. It is thought to be due in part to a prolonged stress response leading to sustained and increased expression of stress-related hormones including catecholamines and glucocorticoids.[40] Initially patients have decreased metabolic rates in the first 48 hours postburn; this gradually increases until around 5 days postburn where it plateaus and can persist for up to 3 years.[41] Care of the burn-injured patient aims to address this response and mitigate negative side effects.

Nutrition

Adequate nutrition is an important component of burn care. Many patients are able to tolerate oral intake but because of their high caloric needs, patients with greater than 20% TBSA burns usually require supplementation with tube feeding. Dietician consultation is recommended and tube feeds should be started early. This will be discussed further in a later article.

Stress Ulcer Prophylaxis

Burn-injured patients are at increased risk for stress ulcers as the systemic response leads to splanchnic hypoperfusion causing gastrointestinal ischemia and mucosal atrophy which decreases mucosal healing and increases the risk of ulceration. Gastric tube feeding/oral intake decreases this risk and we treat with an H2 blocker for prophylaxis in large burns as well as in intubated patients, similar to other critically ill populations.

SPECIAL CONSIDERATIONS

There are some specific cases that require special management and may increase the volume of fluids a patient needs during resuscitation compared to what is expected.

Inhalation Injury

Inhalation injury can add significant mortality to a burn-injured patient. There are three main mechanisms of injury.

Supraglottic injury

Upper airways can suffer thermal damage as hot gases are inhaled and cooled; this is most common in patients who were in an explosion or unconscious in an enclosed fire. This leads to upper airway edema which typically peaks 24 to 48 hours postburn, so these patients often need intubation until the swelling decreases, and they have a cuff leak. We do not recommend routine steroids in these cases.

Subglottic injury

Lower airway inhalation injury can lead to lower airway mucosal damage, triggering an inflammatory cascade that worsens pulmonary function, fluid requirements, and overall metabolic demands. Typically these patients have a history of being trapped in an enclosed space fire or inhaled chemical. Singed nasal hairs and facial burns are less indicative of a true inhalational injury without the right history. Admission labs include carboxyhemoglobin levels which are concerning if > 10. Bronchoscopy may be used

to grade the severity of injury as higher grades are associated with higher morbidity and mortality.[42,43] The treatment is supportive care with aggressive pulmonary toilet and inhaled triple therapy with inhaled heparin to decrease the fibrin plug and airway cast formation, albuterol for bronchodilation, and N-acetylcysteine to combat the free radical damage from the high oxygen concentrations. These patients often need intubation and may go on to develop complications such as ARDS and pneumonia.

Systemic poisoning

Carbon monoxide (CO) is an odorless, colorless gas created by incomplete combustion of carbon-containing materials. It has an affinity for hemoglobin over 200 times that of oxygen which can lead to profound and sometimes irreversible hypoxic damage. The oxygen saturation on the pulse oximetry may be falsely elevated so carboxyhemoglobin levels should be measured. Treatment is with 100% oxygen as it decreases the half-life of CO from about 4 hours to about 1 hour.

Smoke inhalation injury may also lead to hydrogen cyanide poisoning which binds cytochrome oxidase and inhibits cellular respiration. It rarely occurs without smoke inhalation and high levels of carboxyhemoglobin may be a clue to its presence. Treatment is empiric with hydroxocobalamin, which binds the cyanide and increases the rate of excretion. We recommend treating with hydroxocobalamin in patients with a clinical history of smoke inhalation, GCS less than 10, carboxyhemoglobin greater than 10%, and lactate greater than 10 mmol/L.[44]

Electrical Burns

Management of electrical burns partly depends on whether the exposure was low voltage (<1000V) or high voltage (>1000V). This is a convenient division to identify cases where exposure to high doses of electrical current is likely. In both cases, the patient may have cutaneous injuries known as contact points that may give clues to the path of the current. Low-voltage electrical burns, such as those caused by most household exposures, typically have minimal deep tissue injury and contact points may or may not need local wound care depending on the size and location. These patients should get an EKG and if normal, with no loss of consciousness, and manageable symptoms from the burn, can often discharge. One case of note is oral commissure injury for electrical cords in the mouth. These patients have attention to mouth position and range of motion, and watched for bleeding; characteristically around 7 to 10 days postburn the labial branch of the facial artery may bleed. It is managed with direct pressure inside the cheek.

High voltage electrical injuries carry a risk of deeper tissue destruction regardless of the size of the cutaneous wound. These patients should be admitted with cardiac monitoring; we typically observe them in the ICU for at least 24 hours postburn and serially evaluate for compartment syndrome. Due to the risk of neurologic symptoms and cataracts, we also recommend a neurologic exam and an ophthalmic exam during the admission. They are also at risk for rhabdomyolysis from the tissue destruction, so the urine color should be noted to assess for myoglobin; if the urine appears brown or red, we increase the IV fluid rate to target a urine output of 50 to 100 cc/h until the pigment clears. These patients often have an associated trauma and should be examined and evaluated for other injuries.

Chemical Burns

Chemical burns account for about 3% of admitted burn patients.[1] If the chemical exposure is a liquid, it should be irrigated with large volumes of water for at least 30 minutes. If the chemical exposure is dry, this should be brushed off the patient prior to

irrigation. Additional chemicals should not be used to neutralize the substance. Hydrofluoric acid burns lead to hypocalcemia so these patients are treated with topical calcium gluconate to the wound bed as well as IV calcium gluconate for symptomatic hypocalcemia. Refractory hypocalcemia may necessitate emergent excision.[45] Tar burns are managed by first cooling the tar to solidify it and dissipate the heat, then removed with a solvent, such as Neosporin ointment, to dissolve it and prevent further damage from removal.

Non-accidental Trauma

Providers and burn care team must evaluate the burn pattern for consistency with the history of injury to evaluate for NAT, especially in vulnerable populations such as children and the elderly. If this is suspected, it should be reported in accordance with local laws and regulations.

SUMMARY

Burn injuries affect a wide range of patients and are a significant burden on the healthcare system. Prevention is a cornerstone of decreasing this, however once an acute burn arrives at your center, a rapid, multidisciplinary approach is needed to improve outcomes for the patients. Transfer to a burn specialty center may be indicated in some patients given the unique surgical and physiologic management they often require.

CLINICS CARE POINTS

- If accurate %TBSA has not yet been calculated for adult burns >20% TBSA, start fluids at 500cc/hr and titrate hourly based on urine output and vital signs rather than delaying resuscitation.
- The goal of burn resuscitation is to prevent shock rather than react to it so we titrate the fluid rates based on urine output and boluses should be utilzied when there are signs of shock such as hypotension.
- Fluids are a necessary part of the early management of large burn injuries but early recognition of a non-responder is important to mitigate over administartion of non beneficial fluid volume.
- Understanding the mechanism of the burn is important to raise suspicion for additional injuries that require assessment and treatment such as inhalation injury, non-accidental trauma, or concomitant traumatic injuries.

DISCLOSURES

The authors have nothing to disclose.

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